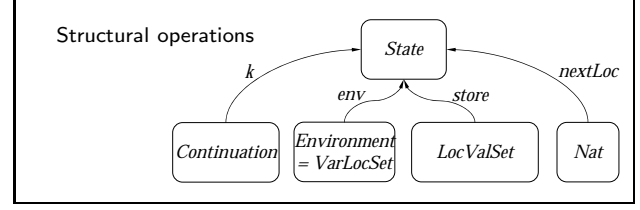


import *BOOL*, *INT*, *REAL*, *K-BASIC*



$$\begin{array}{l}
 \left. \begin{array}{l} \text{eval} : \text{Exp} \rightarrow \text{Val} \\ \text{result} : \text{State} \rightarrow \text{Val} \end{array} \right\} \dots \left\{ \begin{array}{l} \frac{\text{eval}(E)}{\text{result}(k(E) \text{ env}(\cdot) \text{ store}(\cdot) \text{ nextLoc}(0))} \\ \\ \frac{\text{result}(k(V : \text{Val}))}{V} \end{array} \right. \\
 \\
 \left. \begin{array}{l} \text{Var}, \text{Bool}, \text{Int}, \text{Real} < \text{Exp} \\ \text{Bool}, \text{Int}, \text{Real} < \text{Val} \end{array} \right\} \dots \left\{ \begin{array}{l} k(\frac{X}{V}) \text{ env}(\langle X, L \rangle) \text{ store}(\langle L, V \rangle) \end{array} \right. \\
 \\
 \begin{array}{l} \text{not_} : \text{Exp} \rightarrow \text{Exp} \text{ } [!, \text{not}_{\text{Bool}} : \text{Bool} \rightarrow \text{Bool}] \\ \text{_+ _} : \text{Exp} \times \text{Exp} \rightarrow \text{Exp} \text{ } [!, \text{_+}_{\text{Int}} : \text{Int} \times \text{Int} \rightarrow \text{Int}, \text{_+}_{\text{Real}} : \text{Real} \times \text{Real} \rightarrow \text{Real}] \\ \text{_} \leq \text{_} : \text{Exp} \times \text{Exp} \rightarrow \text{Exp} \text{ } [!, \text{_} \leq_{\text{Int}} : \text{Int} \times \text{Int} \rightarrow \text{Bool}, \text{_} \leq_{\text{Real}} : \text{Real} \times \text{Real} \rightarrow \text{Bool}] \\ \text{skip} : \rightarrow \text{Exp} \text{ } [\text{unit} : \rightarrow \text{Val}] \end{array} \\
 \\
 \text{if_then_else_} : \text{Exp} \times \text{Exp} \times \text{Exp} \rightarrow \text{Exp} \text{ } [!(1)[\text{if}]] \left\} \dots \left\{ \begin{array}{l} \frac{\text{bool}(\text{true}) \curvearrow \text{if}(E_1, E_2)}{E_1} \mid \frac{\text{bool}(\text{false}) \curvearrow \text{if}(E_1, E_2)}{E_2} \end{array} \right. \\
 \\
 \left. \begin{array}{l} \text{fun_} \rightarrow \text{_} : \text{VarList} \times \text{Exp} \rightarrow \text{Exp} \\ \text{_}(\text{_}) : \text{Exp} \times \text{ExpList} \rightarrow \text{Exp} \text{ } [!(\text{app})] \\ \text{closure} : \text{VarList} \times \text{Exp} \times \text{VarLocSet} \rightarrow \text{Val} \end{array} \right\} \dots \left\{ \begin{array}{l} k(\frac{\text{fun } Xl \rightarrow E}{\text{closure}(Xl, E, \text{Env})} \text{ env}(\text{Env})) \\ \\ k(\frac{(\text{closure}(Xl, E, \text{Env}), Vl) \curvearrow \text{app} \curvearrow K}{Vl \curvearrow \text{bind}(Xl) \curvearrow E \curvearrow \text{Env}'}} \text{ env}(\frac{\text{Env}'}{\text{Env}})) \end{array} \right. \\
 \\
 \left. \begin{array}{l} \text{let}, \text{letrec} : \\ \text{VarList} \times \text{ExpList} \times \text{Exp} \rightarrow \text{Exp} \end{array} \right\} \dots \left\{ \begin{array}{l} k(\frac{\text{let}(Xl, El, E)}{El \curvearrow \text{bind}(Xl) \curvearrow E \curvearrow \text{Env}} \text{ env}(\text{Env})) \mid k(\frac{\text{letrec}(Xl, El, E)}{\text{bind}(Xl) \curvearrow El \curvearrow \text{write}(Xl) \curvearrow E \curvearrow \text{Env}} \text{ env}(\text{Env})) \end{array} \right. \\
 \\
 \left. \begin{array}{l} [\text{_}] : \text{ExpList} \rightarrow \text{Exp} \text{ } [!, [\text{_}] : \text{ValList} \rightarrow \text{Val}] \\ \text{car}, \text{cdr}, \text{null?} : \text{Exp} \rightarrow \text{Exp} \text{ } [!] \\ \text{cons} : \text{Exp} \times \text{Exp} \rightarrow \text{Exp} \text{ } [!] \end{array} \right\} \dots \left\{ \begin{array}{l} \frac{[V : \text{Val}, \text{_}] \curvearrow \text{car}}{V} \mid \frac{[\text{_} : \text{Val}, Vl] \curvearrow \text{cdr}}{Vl} \\ \\ \frac{[\text{_}] \curvearrow \text{null?}}{\text{bool}(\text{true})} \mid \frac{[\text{_} : \text{Val}, \text{_}] \curvearrow \text{null?}}{\text{bool}(\text{false})} \mid \frac{(V, [Vl]) \curvearrow \text{cons}}{[V, Vl]} \end{array} \right. \\
 \\
 \left. \begin{array}{l} \text{_}; \text{_} : \text{Exp} \times \text{Exp} \rightarrow \text{Exp} \text{ } [!] \\ \text{_} := \text{_} : \text{Var} \times \text{Exp} \rightarrow \text{Exp} \end{array} \right\} \dots \left\{ \begin{array}{l} (V_1 : \text{Val}, V_2 : \text{Val}) \curvearrow \text{_} : \text{_} \mid \frac{X := E}{E \curvearrow \text{write}(X) \curvearrow \text{unit}} \end{array} \right. \\
 \\
 \left. \begin{array}{l} \text{while}(\text{_}) \text{_} : \text{Exp} \times \text{Exp} \rightarrow \text{Exp} \\ \text{_} \circ : \text{Exp} \times \text{Exp} \rightarrow \text{Exp} \rightarrow \text{ContinuationItem} \end{array} \right\} \dots \left\{ \begin{array}{l} \frac{\text{while}(B) E}{B \curvearrow \text{_} \circ (B, E)} \mid \frac{\text{bool}(\text{true}) \curvearrow \text{_} \circ (B, E)}{E \curvearrow B} \mid \frac{\text{bool}(\text{false}) \curvearrow \text{_} \circ (B, E)}{\cdot} \end{array} \right.
 \end{array}$$

Figure 8: K definition of a simple functional language